

# इंटरनेट

# मानक

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IS 12455 (1988): Performance requirements of aircooled spark ignition automotive engines [TED 2: Automotive Primemovers]



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Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”



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## Indian Standard

PERFORMANCE REQUIREMENTS OF  
AIRCOOLED SPARK IGNITION AUTOMOTIVE ENGINES

**1. Scope** — Specifies performance requirements of spark ignition engines of two- and four-stroke cycles type, naturally aspirated, air cooled used for propelling two/three wheeled vehicles.

**2. Definitions** — Shall be in accordance with IS : 10000 (Part 1)-1980 'Methods of tests for internal combustion engines: Part 1 Glossary of terms relating to test methods'.

**3. Types of Engines** — The engines covered under this standard are of the following types:

- a) Automotive air cooled spark ignition engines which do not have built-in cooling air fans such as those used on motorcycles and mopeds.
- b) Automotive air cooled spark ignition engines of the type which have a built-in cooling fan, such as those used on scooters and their three wheeled derivatives (autorickshaw), etc.

#### 4. General Requirements

**4.1** Any engine taken from production and prepared for the type test shall have been well run-in according to manufacturer's recommendations.

**4.2** The auxiliaries, if any attached to the engine shall be specified by the manufacturer.

**4.3** The exhaust smoke emission levels shall comply with IS : 9057-1986 'Emission limits for carbon monoxide for vehicles powered by spark ignition engines (first revision)'.

#### 5. Installation and Adjustments

**5.1** The air cooled automotive engines of the type described in 3 (a) (which do not have built-in cooling fan) shall be provided with an external air cooling arrangement provided on the test bed installation. The external air cooling may be provided by a blower or fan or any other suitable air handling system. The cooling air from the external blower shall flow past the engine in approximately the same direction as it would, when the vehicle is in motion. The air velocity is to be so adjusted that the spark plug seat temperature does not at any time exceed the value specified by the manufacturer. However, the air velocity shall not exceed the maximum vehicle speed plus 5 km/h at level road at same engine/vehicle operating conditions. The minimum value of spark plug seat temperature shall not be lower than the value specified by the manufacturer. In the absence of such data by the manufacturers, the testing authority may arrive at or deduce suitable values in consultation with the manufacturers.

**5.1.1** The blower shall be capable of being moved into such positions with respect to the engine which will give the requisite direction and velocity to cooling air. Any other air handling system shall have suitable means to regulate air velocity. In case duct is used, the area of the duct shall be enough to cover at least the frontal area of the engine.

**5.1.2** The temperature of the cooling air shall be substantially close to the atmospheric temperature, say, within  $\pm 5$  K, to ensure that the air flow past the engine will be simulating the vehicle operational conditions. The temperature shall be measured at the point of entry to the engine and beyond the radiation zone of the engine.

**5.1.3** The spark plug seat temperature shall be measured by placing a copper washer on the spark plug seat below the spark plug and connecting it to a suitable thermocouple or by any other suitable method keeping the spark plug tip position same.

**5.1.4** The engine shall be mounted on the dynamometer stand at the angle at which the engine is installed for the particular vehicle application.

**5.1.5** The exhaust shall be lead out into atmosphere by suitable ducting so that the change in back pressure in the silencer is not appreciable. It is not permissible to interchange the systems of intake and exhaust.

**5.1.6** The engine shall be tested at the crank shaft end or at the gear box output shaft depending upon the manufacturer's declaration and provision on the engine. The point of testing shall be recorded in the test data.

**5.1.7** The manufacturer shall give complete instructions before the commencement of the tests, with regard to the spark plug cleaning period, exhaust port cleaning period and silencer decarbonization period, etc. The manufacturer shall also give details of overhaul and maintenance schedules for the engine.

**5.1.8** A complete record of all deviations and minor adjustments made on the engine during the test shall be maintained and given as appendix to the test report. Minor adjustments and maintenance include spark plug cleaning, exhaust port cleaning, any adjustments of magneto contact breaker points, replacement of ignition coil ( if running hot ), etc.

## **6. Fuels and Lubricants**

**6.1 Fuel** — The fuel shall conform to IS : 2796-1971 'Specification for motor gasolines ( *first revision* )'.

**6.2 Lubricating Oil** — The manufacturer shall provide the complete technical particulars of the lubricating oil that has to be used. A statement of a viscosity grade alone shall not be sufficient for undertaking the tests.

**6.2.1** For two-stroke engines that are lubricated by oil mixed in the fuel, the manufacturer shall state the grades of lubricating oils that have to be used alongwith the percentages to be mixed with the fuel. This shall be stated separately for:

- a) Running-in, and
- b) Performance and endurance tests.

## **7. Declaration of Power Fuel Consumption**

**7.1** The declarations of power are required for two main purposes as follows:

- a) Declaration by a manufacturer of value of the power which the engine will deliver under standard reference conditions. This declared value is known as the 'rated power'. The rated power shall correspond to IS rating as defined in 7.3.
- b) Verification by measurement that the engine delivers the power which has been declared in 7.1 (a) under the same set of reference conditions or after proper allowance has been made for any difference in the ambient site conditions from the standard reference conditions.

**7.2** The declaration of the engine output shall be presented by the manufacturer in the form of performance curves at different operating speeds at full throttle obtained under the reference conditions.

**7.3 IS Rating** — The power measured on a test bed at the crankshaft or its equivalent at the rated speed specified by the manufacturer and corrected to the standard reference conditions, the engine being equipped with auxiliaries, if any, for determination of net power. The power is also defined as rated net brake power.

### **7.4 Power Adjustment Factor**

**7.4.1** The power adjustment factor is determined by the following formula:

$$\left( \frac{P}{100} \right) \times \left( \frac{300}{T} \right)^{0.5}$$

where

$P$  = pressure at site ambient conditions, kPa; and

$T$  = air intake temperature at site ambient, K.

### **7.5 Declaration of Fuel Consumption**

**7.5.1** The engine manufacturer shall state the specific fuel consumption ( SFC ) at rated output under the standard reference conditions and also at 75, 50 and 25 percent of rated load.

**7.5.2** A tolerance of +5 percent in fuel consumption at 100 percent of the rated load throughout the speed range shall be allowed, unless otherwise agreed to between the manufacturer and the purchaser.

**7.5.3** Before the commencement of the tests, the specific gravity of the fuel shall be measured. In case of two-stroke spark ignition engines where pre-mixing of lubricating oil and fuel is done, the specific fuel consumption shall be calculated taking the specific gravity of the fuel alone into consideration (not the specific gravity of the fuel mixed with lubricating oil). However, while carrying out the arithmetical calculations for determining the gravimetric specific fuel consumption, a due allowance for the volume of lubricating oil shall be made.

*Example*

If  $V$  ml of fuel containing  $v$  percent of lubricating oil takes  $t$  seconds for being consumed, while the engine is developing  $P$  kW and the specific gravity of the fuel is  $S$  g/ml, then the specific fuel consumption is given by the following relationship:

$$\text{SFC} = \frac{V}{1 + \frac{v}{100}} \times \left( \frac{3600 S}{P \cdot t} \right) \text{ g/kWh}$$

**Note** —  $v$  percent of oil means  $v$  ml of oil in 100 ml of fuel, that is, in  $(100 + v)$  ml of fuel and oil.

**7.5.4 Specific Fuel Consumption Adjustment Factor ' $\beta$ '** — It is the ratio of the specific fuel consumption under ambient site conditions to the specific fuel consumption under standard reference conditions, that is,

$$\beta = \frac{\text{Specific fuel consumption under ambient site conditions}}{\text{Specific fuel consumption under standard reference conditions}}$$

**7.6** The lubricating oil consumption shall be declared by the manufacturer and shall be determined by any method agreed to between the manufacturer and the testing authority.

## 8. Standard Reference Conditions

**8.1** The standard reference conditions, when different from the stated, shall be recorded. The reference conditions are:

Total barometric pressure	:	100 kPa
Air temperature	:	298 K
Relative humidity	:	30 percent.

**Note:**

Total barometric pressure	=	100 kPa
Air temperature	=	300 K
Relative humidity	=	60 percent

These conditions are also still permissible as reference conditions for a period of five years.

**8.2** Performance data shall be obtained under stabilized normal operating conditions, with an adequate fresh air supply to the engine. If the ambient test conditions are different from the standard reference conditions as given in 8.1 the performance data shall be adjusted to the standard reference conditions.

**8.3** No data shall be recorded until torque, speed and temperature have been maintained within one percent for at least 30 seconds.

**8.4** Observed brake load and fuel consumption data shall be taken simultaneously and shall be the average of two stabilized sustained values which do not vary by more than one percent. A time measurement of not less than 10 seconds shall be used when measuring speed and fuel consumption with an automatically synchronized counter-timer combination. For hand operation, the time of measurement shall be not less than 20 seconds.

## 9. Tests

**9.1 Type Tests** — Shall be carried out on engines when first offered and shall also be conducted when there is any significant change in design of the engine or change in any of the critical component or change in any declared parameter such as power and specific fuel consumption. Type tests shall include the tests in the following sequence:

- Preparation of tests according to IS : 10000 (Part 5)-1980 'Methods of tests for internal combustion engines: Part 5 Preparation for tests and measurements for wear'.
- Preliminary run,

- c) Initial performance tests,
- d) 100 hour test, and
- e) Final performance tests.

**9.1.1 Preparation of tests and wear measurements — General requirements for tests:**

- a) The manufacturer shall supply the performance characteristics of the engine prior to the commencement of the tests and all other information, as required.
- b) The engine offered by the manufacturer for the tests shall be from regular production line, and run-in for the period recommended by him. All parts essential for engine operation shall be included.
- c) The manufacturer shall supply a set of printed literature giving technical specifications, operating instructions, servicing schedule and wear limits of various components listed in 9.1.1 (d).
- d) *Preparation for tests* — The engine shall be completely dismantled and examined physically so that design features and also the conditions of the various parts may be noted before tests are commenced. After the physical examination, the dimensions of the main working parts, listed below, shall be checked and recorded in the proforma given in IS : 10000 ( Part 5 )-1980:
  - 1) Cylinder head,
  - 2) Cylinder bore/cylinder liner,
  - 3) Piston,
  - 4) Piston rings,
  - 5) Gudgeon pin,
  - 6) Valves ( inlet and exhaust ),
  - 7) Valve seats ( inserts ),
  - 8) Valve guides,
  - 9) Valve springs,
  - 10) Connecting rod,
  - 11) Big end bearing,
  - 12) Small end bush,
  - 13) Connecting rod bolts and nuts,
  - 14) Crankshaft,
  - 15) Crankshaft bearings and journals,
  - 16) Camshaft, and
  - 17) Timing gears ( backlash shall be measured before and after endurance test ).
- e) The engine shall then be re-assembled by ( or under the supervision of ) the manufacturer, mounted on a suitable test bed and run-in for the period and in the manner recommended by the manufacturer. The running-in period shall be stated by the manufacturer. In case the engine has not been run-in by the manufacturer prior to offering for test, the engine shall be run-in for a period and in the manner recommended by the manufacturer and this shall be mutually agreed between the manufacturer and the purchaser or the inspecting authority. During the running-in, none of the critical components listed above shall be allowed to be replaced. In case any of these parts need to be changed during running-in, the engine shall be discarded and fresh engine selected for testing.
- f) After completion of running-in, the servicing of the engine shall be carried out in accordance with the manufacturer's schedule.
- g) No modifications/replacements shall be allowed during the running-in and regular testing which have direct bearing on the performance of the engine. If any modification/alternation is considered necessary by the manufacturer, he may withdraw the engine from the test and submit another engine incorporating the required changes. The changes carried out by the

manufacturer shall be stated and he shall have to complete all the necessary formalities for tests separately for the testing of the modified engine.

**9.1.2 Preliminary run** — Shall be carried out after the engine is well run-in. The engine shall be fitted with the auxiliaries required to enable it to give the net output at standard reference condition. The sequence of running shall be as given in Table 1. The speeds shall be rounded to nearest 100.

TABLE 1 PRELIMINARY RUN		
Engine Speed (Percent of Maximum Speed)	Load (Percent of Rated Load)	Time (Minutes)
Idling	0	Up to 30
40	30	30
50	30	30
70	40	30
85	40	30
40	50	30
45	60	30
50	60	30
60	60	30
70	60	30
80	60	30
85	60	30
95	60	30
100	80	30
60	80	30
70	80	30
100	100	30
70	100	30
85	100	30
100	100	30

## 9.2 Initial Performance Test

**9.2.1 Test procedure** — The performance of the engine shall be assessed by drawing a power curve over normal full load speed range. Readings shall be taken at a minimum of six approximately evenly spaced settings after stable conditions are reached over the normal speed range from maximum rated speed at full load to 45 percent of this speed or 1 000 rev/min, whichever is lower. At all these points, the fuel pump shall be set at its maximum fuel delivery stop.

**9.2.2** The performance data shall be presented in the form of graphs recording power output, torque, specific fuel consumption and smoke density duly corrected.

**9.2.3 Idling test** — With engine at the working temperature specified by the manufacturer, it shall be ascertained if the engine idles satisfactorily for at least five minutes.

**9.2.4 Acceleration test** — With dynamometer set for speed giving the maximum brake power at full throttle, the engine shall be accelerated abruptly from idling to full throttle. The engine shall pick up the speed easily. This test shall be carried out three times. The test shall also be repeated on 40 percent maximum dynamometer speed.

**9.2.5 Speed limiter (or governor) check** — The speed limiter or governor shall be checked for the high idling speed specified by the engine manufacturer.

## 9.3 Endurance Test

**9.3.1 Test procedure** — The test shall be conducted after the initial performance test and the speed limiter or governor check as specified in 9.2.1, 9.2.2 and 9.2.5. The test shall last for a total of 100 hours running time and shall consist of not-stop running periods of 10 hours duration with not less than 2 hours stoppage between consecutive running periods.

**9.3.2** Each running period shall consist of five cycles of two hours duration made up of the following sequence of engine running conditions:

- 50 minutes at 75 percent of full load at the declared maximum speed;



- b) 45 minutes at full load at speed corresponding to maximum torque;
- c) 5 minutes at idling; and
- d) 20 minutes at full load at declared maximum speed.

**9.3.3** During the tests, lubricating oil recommended by the manufacturer shall be used.

**9.3.4** Before starting the next cycle, the engine shall have reached within 5 K of the room temperature.

**9.3.5 Results of the test** — The above results corrected to standard reference conditions shall be plotted on a time scale in accordance with IS : 10000 ( Part 6 )-1980 'Methods of tests for internal combustion engines: Part 6 Recording of test results'.

**9.3.6** The corrected power and the corrected torque shall at no time fall by more than 5 percent of the initial readings ( at corresponding speeds ) for more than two consecutive readings.

**9.3.7** The corrected specific fuel consumption shall at no time increase by more than 5 percent above the initial performance test values.

**9.3.8** A maximum of two interruptions to correct any fault or mal-adjustment shall be permitted during the full duration of the test. The nature of such adjustments shall be recorded.

**9.3.9** If the engine needs to be stopped during any cycle for any minor attention, the running time of that cycle shall not be counted as part of the test and the cycle shall be recommended. In case of power breakdown or breakdown of testing equipment, the test cycle shall not be scrapped and the remaining cycle time shall be completed on resumption of power or repair of test equipment as the case may be. In case of major breakdown, the entire test shall be repeated from the beginning on another engine. For this purpose, a minor breakdown is one which requires normal service adjustments and replacements as recommended by the manufacturer and a major breakdown is one which requires complete overhaul and changing of parts not covered by normal service adjustments and replacements. The major breakdown will also mean the breakdown or replacement of any of the critical components of the engine.

**9.3.10** During the endurance tests, periodic checks shall be made of the fuel and oil. The oil shall conform to the specifications of the manufacturer.

#### **9.4 Final Performance**

**9.4.1** After the 100 h tests, the engine shall be tested for final performance in the way outlined in 9.2.

**9.4.2** The corrected power and torque throughout the running speed range shall not drop by more than five percent from the corresponding initial performance test values.

**9.4.3** The corrected specific fuel consumption shall at no point throughout the running speed range increase by more than five percent from the corresponding value obtained during initial performance test.

**9.4.4** The corrected exhaust gas opacity shall at no point in the running speed range exceed the limiting values given in IS : 10000 ( Part 10 )-1980 'Methods of tests for internal combustion engines: Part 10 Tests for smoke levels, limits and corrections for smoke levels for variable speed compression engines'.

**9.5 Fuel Consumption** — Shall be measured at the beginning of the endurance and final performance tests. The specific fuel consumption shall be stated by the manufacturer at rated net power under standard reference conditions. The specific fuel consumption at site conditions shall be connected to standard reference condition.

**9.6 Determination of Power** — Shall be computed after taking at least five approximately evenly spaced operating speed, to define complete the power curve between the lower stable speed on load and the maximum engine speed on load recommended by the manufacturer.

**9.7 Test Results** — Shall be recorded as per IS : 10000 ( Part 6 )-1980.

**9.8 Information on Enquiry or Order and Information to be Supplied by the Manufacturer** — Shall be as given in IS : 10000 ( Part 11 )-1980 'Methods of tests for internal combustion engines: Part 11 Information required with enquiry or order and information supplied by manufacturer with the engine'. Any other special characteristics or relevant data for testing shall also be supplied by the engine manufacturer.

**10. Marking** — The engines shall be clearly marked with the following on the engine name plate/data plate:

- a) Engine number;
- b) Volumetric capacity; and
- c) Manufacturer's name or trade-mark and code number.

**10.1** The information regarding maximum rated output at rated speed in kW, maximum speed (rpm), maximum torque (Nm), SFC (g/kWh), and specifications of lubricating and fuel oil shall be given in the manual provided to the purchaser.

**10.2 Standard Mark** — Details available with the Bureau of Indian Standards.

**11. Test Certificate** — Shall be provided by the testing authority/manufacturer in the proforma given in IS : 10000 (Part 12)-1980 'Methods of tests for internal combustion engines: Part 12 Test certificates'.

**12. Packing** — The engines shall be suitably crated so as to avoid damage during transit.

## EXPLANATORY NOTE

This standard has been prepared for covering special needs for conducting all tests on the classes of engines which are used in motorcycles, mopeds. These tests are also applicable to engines which are used on scooters, three-wheelers and can be extended to, in the absence of any standard, outboard motors for marine or rivercraft. The testing needs of all these classes of engine covered under this specification are covered by the following three characteristic problems:

- a) Difficulties of ascertaining the mechanical efficiency,
- b) Simulating the vehicle slip stream on test beds, and
- c) Lubrication being provided by mixing of lubricating oil with the fuel.

This Indian standard specification has been drawn to supplement IS : 10000 (Parts 1 to 12)-1980, IS : 10004-1981 'Performance requirements for spark ignition engines for automotive purposes' and IS : 7347-1974 'Performance of small size spark ignition engines'.